

# 73

## The Plantar Reflex

H. KENNETH WALKER

### Definition

Stroking the lateral part of the sole of the foot with a fairly sharp object produces plantar flexion of the big toe; often there is also flexion and adduction of the other toes. This normal response is termed the *flexor plantar reflex*.

In some patients, stroking the sole produces extension (dorsiflexion) of the big toe, often with extension and abduction ("fanning") of the other toes. This abnormal response is termed the *extensor plantar reflex*, or *Babinski reflex*.

### Technique

Place the patient in a supine position and tell him or her that you are going to scratch the foot, first gently and then more vigorously. Fixate the foot by grasping the ankle or medial surface with the examiner's hand that will be closest to the midline of the patient: examiner's left hand when the patient's left foot is being tested, and vice versa with the right foot. Begin with light stroking, using your finger; then use a blunt object such as the point of a key. Finally, if no abnormal response has been obtained, take a tongue blade and break it in half longitudinally and use the sharp point. The reason for the graded stimuli is twofold: (1) Light touch, as with a finger, frequently obtains the reflex without causing a withdrawal response that on occasion makes interpretation of the response difficult; (2) one cannot conclude the response is normal until a noxious stimulus is indeed used, since the reflex is a cutaneous nociceptive reflex.

The first line to be stroked begins a few centimeters distal to the heel and is situated at the junction of the dorsal and plantar surfaces of the foot (Figure 73.1). The line extends to a point just behind the toes and then turns medially across the transverse arch of the foot. Stroke slowly, taking 5 or 6 seconds to complete the motion. Do not dig into the sole, but stroke.



**Figure 73.1**  
Testing the plantar reflex.

Successive lines are stroked, each about 1 cm medial to the preceding stroke, until the examiner is stroking the midline of the foot. The reason for beginning laterally is that in some cases the response is abnormal laterally and then becomes normal as the midline is approached. The occurrence of the extensor response on any of these lines is abnormal, even if the response is flexor on another line of stroking. This variation relates to variability in the receptive field of the reflex, undoubtedly due to the extent of corticospinal involvement as well as individual differences.

The reflex is normal if the abnormal response is not obtained from any of the stroke lines using all of the stimuli described.

A good habit is to describe whatever response is obtained in addition to noting whether in your opinion the response is normal or abnormal.

### Basic Science

The neurophysiology of this reflex has not been completely elucidated. The account given here follows the suggestions made by Kugelberg, Eklund, and Grimby (1960) and is the result of their electromyographic studies. Each area of the skin of the body appears to have a specific reflex response to noxious stimuli. The purpose of the reflex is to cause the withdrawal of the area of the skin from the stimulus. This reflex is mediated by the spinal cord, but influenced by higher centers. The area of skin from which the reflex can be obtained is known as the receptive field of the reflex. To be more specific, a noxious stimulus to the sole of the foot, which is the receptive field, causes immediate flexion of the toes, ankle, knee, and hip joints with attendant withdrawal of the foot from the stimulus. Remember your own experiences with this reflex, an example being stepping on a sharp object while barefoot. There is an instant involuntary flexion of all joints with withdrawal. Another reflex in the normal individual is the great toe reflex: Stimulation of the ball of the toe, which is the receptive field, causes extension (dorsiflexion) of the toe with flexion at ankle, knee, and hip joints. The differences between these two reflexes are in the receptive fields and the fact that the great toe is flexed in one and extended in the other. The reason for the extension in the toe reflex is to remove the toe from the stimulus.

The abnormal plantar reflex, or Babinski reflex, is the elicitation of toe extension from the "wrong" receptive field, that is, the sole of the foot. Thus a noxious stimulus to the sole of the foot produces extension of the great toe instead of the normal flexion response. The essential phenomenon appears to be recruitment of the extensor hallucis longus, with consequent overpowering of the toe flexors (Landau, 1971). The movements of the other joints remain the same.

The corticospinal tract influences the segmental reflex

in the spinal cord. When the corticospinal tract is not functioning properly, the result is that the receptive field of the normal toe extensor reflex enlarges at the expense of the receptive field for toe flexion. Toe extension is consequently elicited from what is normally the receptive field for toe flexion. The maintenance of territorial integrity of the receptive fields is apparently one way in which the cortex exerts its influence under normal conditions.

### Clinical Significance

The plantar reflex is a nociceptive segmental spinal reflex that serves the purpose of protecting the sole of the foot. The clinical significance lies in the fact that the abnormal response reliably indicates metabolic or structural abnormality in the corticospinal system upstream from the segmental reflex. Thus the extensor reflex has been observed in structural lesions such as hemorrhage, brain and spinal cord tumors, and multiple sclerosis, and in abnormal metabolic states such as hypoglycemia, hypoxia, and anesthesia.

There is disagreement about whether the response is plantar flexion or dorsiflexion in the majority of newborns (Hogan and Milligan, 1971; Ross et al., 1976). In all cases, however, the response does become flexor by the sixth to twelfth month of life.

On rare occasions the extensor reflex has been reported in individuals who were otherwise normal; however, there is no long-term follow-up of these cases reported in the literature. In summary, there is widespread agreement among neurologists that an extensor plantar response about the sixth to twelfth month of life indicates structural or metabolic dysfunction of the corticospinal system.

The receptive field for the extensor plantar response can be quite extensive. On occasion the extensor reflex has been elicited by stimulating as high as the face. Even in the same individual there is often shrinkage in the receptive field as time passes after the occurrence of the lesion.

The reflex response is on occasion equivocal. For example, there may be flexion of the toes before extension.

Landau has addressed very nicely this question of an initial flexor movement of the toe followed by extension:

But even when the abnormal response is maximally developed, as in our illustrated case of paraplegia, early flexion may occur, especially with threshold stimulation. What these observations amount to practically is that competent clinical judgment of this peculiar behavior, God's gift to the neurologist, has more validity than an arbitrary rule concerning the initial direction of hallux movement. (Landau and Clare, 1959)

On occasion, the reflex may be unequivocally flexor on one side and the toe remains neutral without movement on the other side. Under these circumstances the question is whether there is evidence of corticospinal tract dysfunction, and not whether the response is flexor or extensor.

This question can often be answered by looking for other evidence of corticospinal dysfunction, such as repeating deep tendon reflexes. Table 73.1 gives a number of other signs that indicate corticospinal dysfunction, just as the Babinski sign. Occasionally one of them may be positive when the Babinski is not present. Sometimes it is helpful to do two of them together, such as the Babinski and the Oppenheim, or the Babinski and the Gordon. The Babinski sign is the most reliable, and the one most likely to be present initially. Excellent discussions of these various signs may be found in DeJong (1979) and Van Gijn (1977).

### References

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**Table 73.1**  
Variants of the Babinski Sign

Eponym	Technique
Chaddock (1911)	The skin under and around the lateral malleolus is stroked in a circular fashion. The stimulus may also be carried forward from the heel to the small toe.
Bing (1915)	The dorsum of the big toe is pricked with a pin. The big toe withdraws into the pin when abnormal, as opposed to being flexed away from the stimulus when normal. This sign and the Chaddock sign are perhaps the most reliable after the Babinski sign.
Oppenheim (1902)	The thumb and index finger apply heavy pressure to the anterior surface of the tibia, stroking down to the ankle.
Gordon (1904)	Compressing the calf muscles, or applying deep pressure to them.
Schaefer (1899)	Pinching the Achilles tendon enough to cause pain.